

# AI-Powered USB Handbook

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USB

*AI-Powered USB Handbook Team*

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# 1. AI-Powered USB Handbook

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## AI-Powered USB Handbook

AI-Powered USB Handbook	USB	USB 3.2 Gen 2x2	Thunderbolt 4 ( 4)
Type-C			

## 1.1

---

- -
- **USB** - USB
- **USB** -
- **Thunderbolt** -
- - USB PD
- -

## 1.2

---

- 
- 
- 
-

## 2. 1 (Introduction)

2.1

# USB (Universal Serial Bus) Type-C

USB

USB 3.2 Gen 2x2

**AI-Powered USB Handbook**

USB

AI

2.2

- 4 USB4
  - USB

2.3

- 1.
  2.           USB 1.0    USB4
  3.           Intel       Thunderbolt        USB
  4.           USB PD      PPS
  - 5.

## 3. 2 :USB (USB Connector Types)

---

USB

### 3.1 USB

#### 3.1.1

USB 1996 Type-A Type-B

- MP3
- 
- 
- 

[!IMPORTANT] 2024

**USB Type-C**

iPhone 15

Type-C

#### 3.1.2 USB

```
timeline
title USB
1996 : USB 1.0 : Type-A / Type-B : 1.5Mbps ( )
1998 : USB 1.1 : 12Mbps ( )
2000 : USB 2.0 : 480Mbps ( ) : Type-A/B
2000 : Mini USB : Mini-A / Mini-B :
2007 : Micro USB : Micro-A / Micro-B : <br> Mini USB
2008 : USB 3.0 : 5Gbps ( ) : Type-A/B <br>
2013 : Micro USB 3.0 :
2014 : USB Type-C : <br> :
2017 : USB 3.2 : 20Gbps : Type-C
2019 : USB4 : 40Gbps : Type-C
2024 : Type-C :
```

#### 3.1.3

**Type-A** - Type-A 1996 - USB 3.2 Type-A

**Micro USB** - 2007-2020 - Micro USB - Type-C

**Type-C** - 2014 Lightning - 2024 -

### 3.2 USB Type-A

---

USB

- 
- 12mm × 4.5mm
- 1,500

### 3.2.1

#### USB 2.0 Type-A 4

1	VBUS	(+5V)
2	D-	
3	D+	
4	GND	

#### USB 3.0/3.1/3.2 Type-A 9

USB 2.0	4	5				
5		StdA_SSRX-				
6		StdA_SSRX+				
7		GND_DRAIN				
8		StdA_SSTX-				
9		StdA_SSTX+				

[!NOTE] USB 3.0+    5                  USB 2.0    4                  USB 3.0              USB 2.0        4

### 3.2.2

#### USB-IF

/	USB 2.0	480Mbps
	USB 3.0/3.1 Gen 1	5Gbps
<b>Teal</b>	USB 3.1 Gen 2	10Gbps
	USB 3.2 /	20Gbps
/		BC 1.2

[!TIP]                          USB 3.0+    /                  USB 2.0

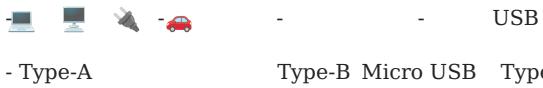
### 3.2.3

<b>USB</b>			
USB 2.0	500mA	2.5W (5V 0.5A)	
USB 3.0	900mA	4.5W (5V 0.9A)	
USB BC 1.2	1.5A	7.5W (5V 1.5A)	(DCP)
USB 3.1/3.2	3A	15W (5V 3A)	

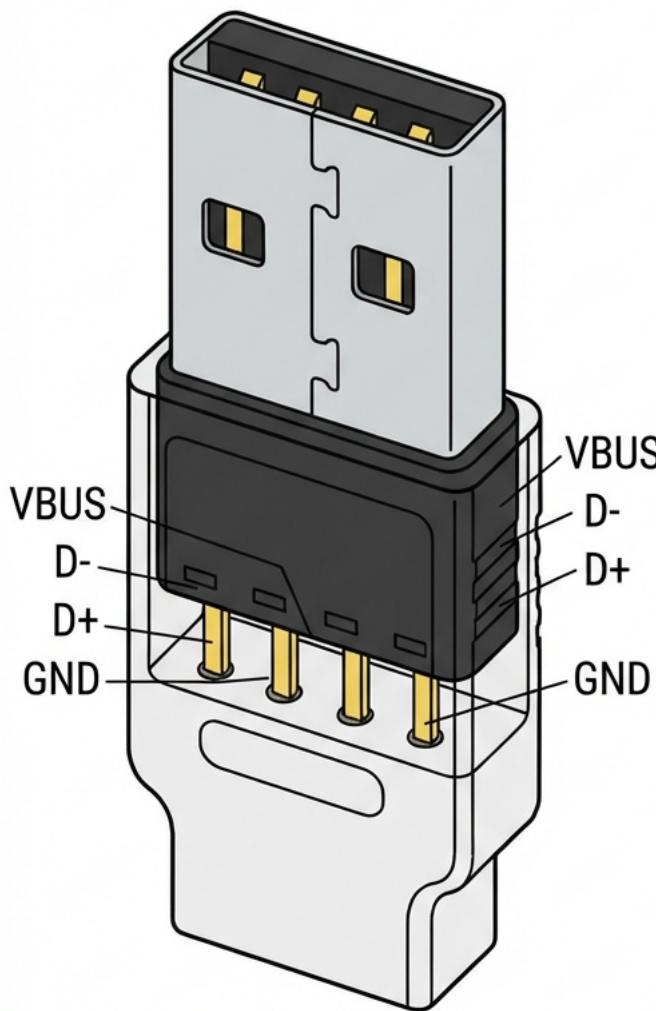
[!WARNING] Type-A      USB PD      >15W      **Type-C**

---

### 3.2.4

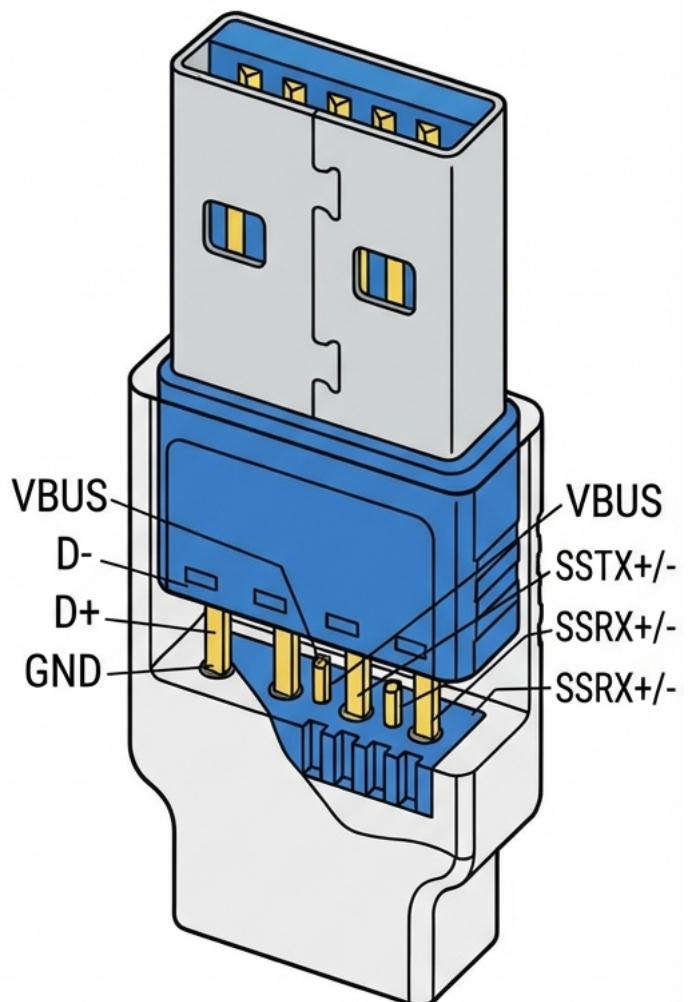


USB 2.0 Type-A



USB 2.0 Type-A

USB 3.0 Type-A (SuperSpeed)



USB 3.0 Type-A (SuperSpeed)

### 3.3 USB Type-B

Type-B

Type-A

Type-B

#### 3.3.1 Type-B

##### Standard-B

- 
- 8mm × 7mm
- 4 USB 2.0 9 USB 3.0
-

**Mini USB Type-B**

- Standard-B
- 7mm × 3mm
- 5
- MP3 GPS
- Micro USB

**Micro USB Type-B**

- 
- 7mm × 1.8mm
- 5 USB 2.0
- 2007-2020
- Type-C

**Micro USB 3.0 Type-B**

- Micro USB 2.0
- 12mm × 1.8mm
- 10 5 USB 2.0 + 5 USB 3.0
- Elements Backup Plus Galaxy Note 3/S5
- Micro USB 2.0

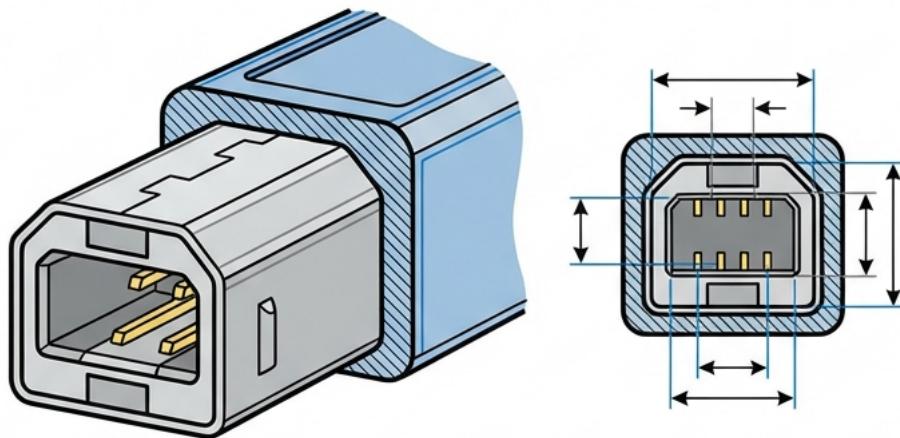
```
graph LR
    A[Standard-B<br/> <br/> ] --- B[Mini-B<br/> <br/>MP3/ ]
    B --- C[Micro-B<br/> <br/> ]
    C --- D[Micro-B 3.0<br/> <br/> ]
```

```
A -->| | B
B -->| | C
C -->| | D
```

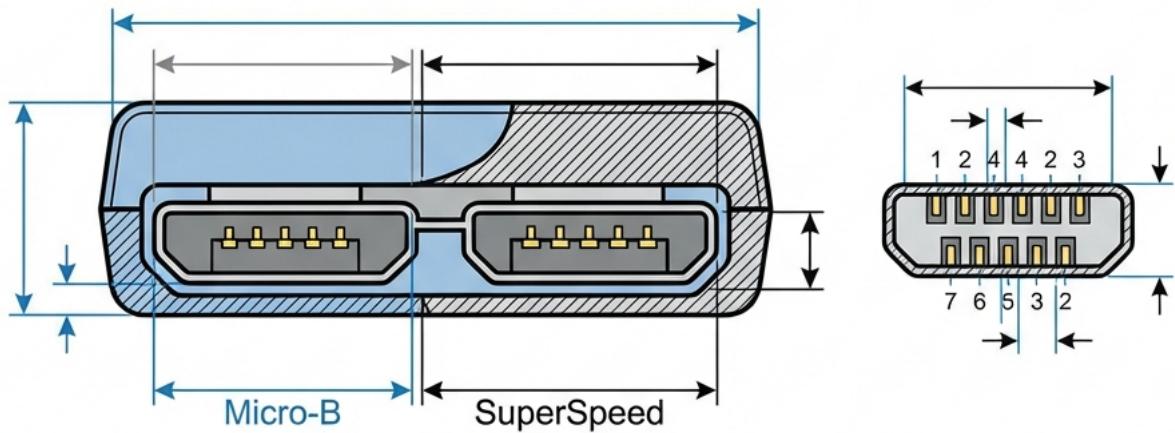
```
style A fill:#e1f5ff
style B fill:#ffff4e1
style C fill:#e1ffe1
style D fill:#ffe1e1
```

**3.3.2 Type-B**

- Type-B USB " "
- Standard-B
- **Type-C** Type-C



**USB Standard-B  
(Printer)**



**USB Micro-B SuperSpeed  
(External HDD)**

### 3.4 Mini USB & Micro USB

#### 3.4.1 Mini USB

- 2000
- Standard-B
- 5

- **Mini-A**
  - **Mini-B**
  - **Mini-AB**              OTG
  - MP3              GPS
  - **2007 Micro USB**
- 

### 3.4.2 Micro USB

#### Micro USB 2.0 Type-B

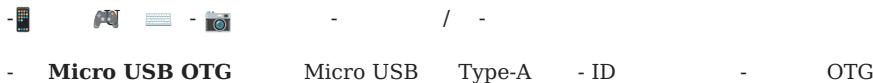
5

1	VBUS	(+5V)
2	D-	
3	D+	
4	ID	OTG
5	GND	

- ID              **OTG (On-The-Go)**              - ID              U              - ID              -              7mm × 1.8mm  
 Mini USB      -      10,000

#### OTG (On-The-Go)

OTG



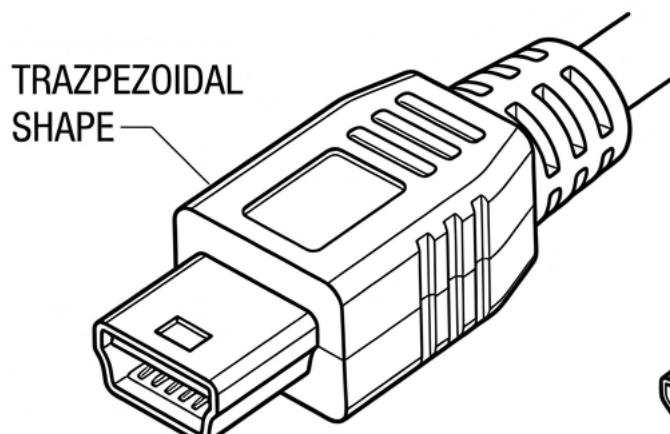
### 3.4.3 Micro USB

#### Micro USB

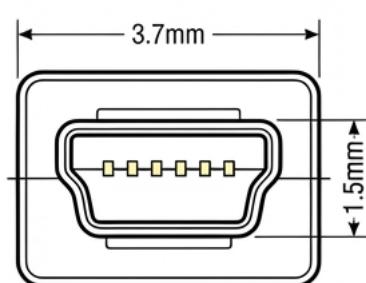
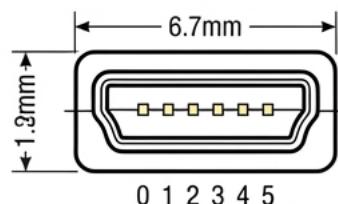
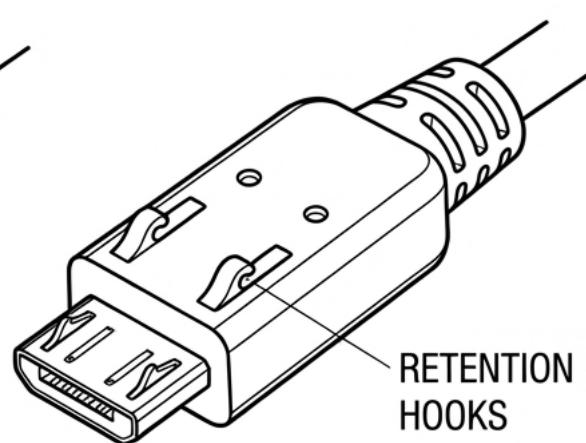
1.      - **✗**              **✗** **✗**      -
2.      -      10,000      -
3.      -      Micro USB      **USB 2.0** 480Mbps      -      4K      - Micro USB 3.0      5Gbps
4.      -      7.5W (5V 1.5A, BC 1.2) -      30W+
5.      -      -      Alt Mode

[!WARNING]      Micro USB

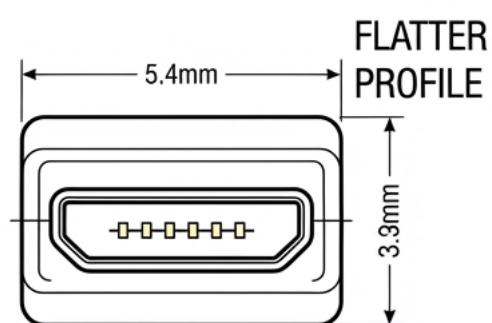
# MINI USB



# MICRO USB



# MINI USB



# MICRO USB

## 3.5 USB Type-C

- 8.4mm × 2.6mm
- 10,000 Micro USB
- 2014

[!IMPORTANT] Type-C

Type-C

USB 2.0

4 (40Gbps)

### 3.5.1 Type-C

1.
  2.  + + +
  3.  240W (USB PD 3.1)
  4.  40Gbps (USB4 / Thunderbolt 4)
  5.
  6.
- 

### 3.5.2 Type-C 24

Type-C **24**

12	A1 GND   A2 TX1+   A3 TX1-   A4 VBUS   A5 CC1   A6 D+   A7 D-   A8 SBU1   A9 VBUS   A10 RX2-   A11 RX2+   A12 GND
12	B12 GND   B11 RX1+   B10 RX1-   B9 VBUS   B8 SBU2   B7 D-   B6 D+   B5 CC2   B4 VBUS   B3 TX2-   B2 TX2+   B1 GND

	8	VBUS (A4, A9, B4, B9) GND (A1, A12, B1, B12)	240W
<b>USB 2.0</b>	4	D+ (A6, B6) D- (A7, B7)	USB 2.0 480Mbps
<b>USB 3.x/4</b>	8	TX1+/- (A2, A3) RX1+/- (B10, B11) TX2+/- (B2, B3) RX2+/- (A10, A11)	TX/RX 5-40Gbps
	2	CC1 (A5) CC2 (B5)	PD
	2	SBU1 (A8) SBU2 (B8)	Alt Mode

[!NOTE] Type-C

---

### 3.5.3 CC

**CC**

**CC (Configuration Channel)** Type-C

1.

2. CC1 CC2

3. " "

4. **(DRP: Dual-Role Power)**

5. **Source Sink**

6. Type-C

7.

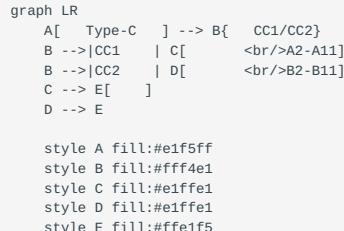
8. Source CC

9. **Default (500mA/900mA) 1.5A 3A**

10. **USB PD**

11.

12. PD Source\_Capabilities Request



### 3.5.4 Alt Mode Type-C

**Alternate Mode ( ) Type-C USB**

#### Alt Mode

- 1. DisplayPort Alt Mode -** Type-C - - - / - Type-C HDMI/DP - 8K@60Hz DP  
2.0 - USB 3.x TX/RX
- 2. Thunderbolt 3/4 Alt Mode -** PCIe DisplayPort USB - 40Gbps - (eGPU) - SSD -  
Thunderbolt 3/4 Type-C
- 3. HDMI Alt Mode -** HDMI - Type-C HDMI
- 4. Audio Adapter Accessory Mode -** - Type-C 3.5mm - SBU1/SBU2

#### Alt Mode



```

style A fill:#e1f5ff
style B fill:#ffff4e1
style C fill:#e1ffe1
style D fill:#ffe1e1
style E fill:#ffe1ff

```

[!TIP] Type-C Alt Mode " " "DP Alt Mode"

### 3.5.5 Type-C vs Type-C

Type-C " "

USB 2.0	USB 3.x	Type-C	Thunderbolt 4
480Mbps	5-20Gbps	5-40Gbps	40Gbps
15W	100W	240W (PD 3.1)	100W
✗	✗	✓ (DP Alt Mode)	✓ (DP 2.0)
✗	✗	✗	✓
💰	💰💰	💰💰💰	💰💰💰💰
/PC		/	/Mac

" "  
- USB 2.0 Type-C iPhone 15 - USB 3.x PHY - \$1-2 - 480Mbps - Type-C -  
DP Mux -  
[!WARNING] Type-C - DeX - Type-C - USB  
PD

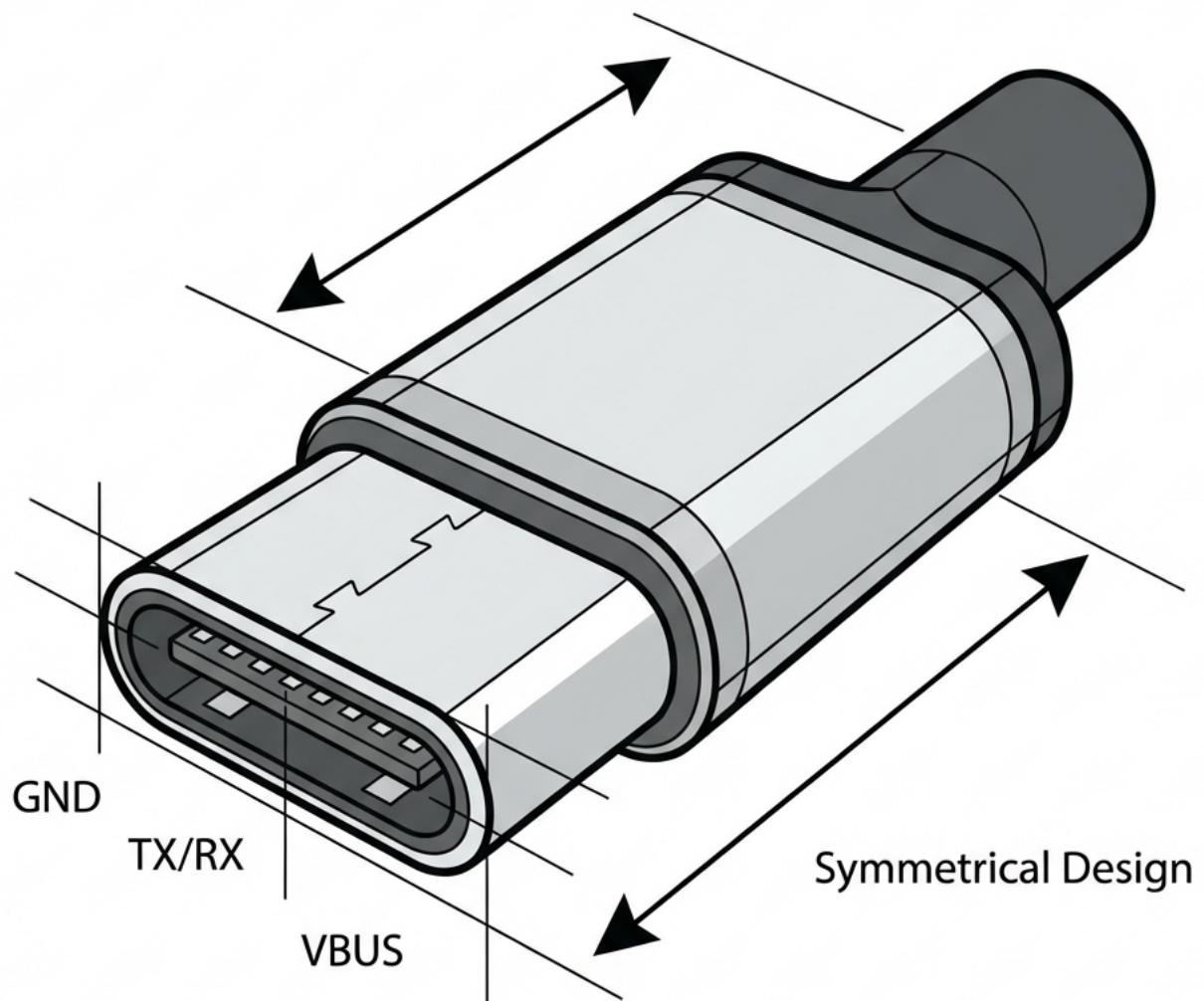
### 3.5.6 Type-C Thunderbolt

Thunderbolt 3/4 Type-C Type-C ≠ Thunderbolt

USB Type-C	Thunderbolt 3/4
USB2.0~USB4 (480Mbps-40Gbps)	40Gbps
+	+ + +PCIe
USB-IF	Intel
USB	⚡

#### Thunderbolt

⚡ 1 2 3 4 - Thunderbolt 3/4 "3" 🖥 - MacBook Thunderbolt  
- eGPU - 40Gbps - Daisy Chain



## 3.6 USB

### 3.6.1

(mm)					
<b>Type-A</b>	12×4.5	4/9		20Gbps (USB 3.2)	15W
<b>Standard-B</b>	8×7	4/9		20Gbps	1,500
<b>Mini USB</b>	7×3	5		480Mbps	2.5W
<b>Micro USB</b>	7×1.8	5		480Mbps	7.5W
<b>Micro USB 3.0</b>	12×1.8	10		5Gbps	7.5W
<b>Type-C</b>	8.4×2.6	24		40Gbps (USB4)	10,000

[!TIP] " " " "

## 3.7

### 3.7.1 USB

1. - Type-A      - Type-C      - Micro USB
2.      Type-A - ● USB 3.0/3.1 Gen 1 (5Gbps) / USB 2.0 (480Mbps) - ○ USB 3.2 -
3. - SS (SuperSpeed) USB 3.0 (5Gbps) - SS 10 SS+ USB 3.1 Gen 2 (10Gbps) - SS 20 USB 3.2 (20Gbps) - ⚡ Thunderbolt 3/4 (40Gbps) - USB-IF

Type-C Marker      -X 100W ✓A - Thunderbolt 40Gbps + 100W      - USB 2.0 USB 2.0 4✓Mbps - USB 3.x ✓ - E-  
 1. SS 5A Thunderbolt      2. USB POWER-Z      3.

### 3.7.2 FAQ

- Q1:** Type-C - A: Charge-Only Cable " "
- Q2: Type-C Type-A** - A: - Type-A USB 3.2: 20Gbps - Type-A 15W USB PD -
- Type-C Alt Mode
- Q3:** Type-C - A: - " " "DP Alt Mode" - " USB PD" - "USB 3.x/4" -
- Q4: Micro USB OTG** U - A: OTG ID " " U Micro USB ID
- Q5: Type-C** - A: - ⚡ 10 ⚡ ⚡ USB 2.0 - ⚡ ⚡ ⚡ 50 USB 3.x + - 100+ +E-  
 Marker+USB-IF ⚡ ⚡ ⚡ ⚡ 200+ Thunderbolt 40Gbps
- Q6:** Type-C PD - A: 1. USB PD 2. USB PD 3. 3A 5A E-  
 Marker 4.

## 3.8

### 3.8.1

<b>USB</b>	USB 3.0	USB 2.0	80Mbps	-	USB 3	USB 2.0	-	Type-C	Type-A	-

### 3.8.2

<b>Type-C to Type-A</b>	Type-A	15W	
<b>Type-C to HDMI/DP</b>	N/A		
<b>Micro USB to Type-C</b>	USB 2.0 (480Mbps)	7.5W	
<b>Thunderbolt to Type-C</b>	40Gbps	100W	

[!WARNING]

### 3.8.3

1. - Micro USB Type-A - Type-C
2. - - 24 - -
3. - **Micro USB** - **Type-C** - **Type-A**
4. - - - - >45°C

## 3.9

### 3.9.1

#### Type-C

<b>1</b>	-	- 30W	3A	20	- 67W-100W	E-Marker	5A	40-80	- 100W	EPR	100+	-
Anker	Baseus	UGREEN Apple										
<b>2</b>	-	- USB 2.0	10-20	- /	USB 3.2	30-60	-	Thunderbolt 4	200+	-	- 1	- 1-2
- 3												
<b>3</b>	- Type-C to HDMI/DP	4K@60Hz	-	2	-	Belkin	Cable Matters	Club 3D				
	<b>USB-IF</b>	<a href="http://usb.org">usb.org</a>	<b>Thunderbolt</b>		-							

### 3.9.2

- 2× Type-A (USB 3.0) - 1× Type-C (USB 3.1 + PD ) - 1× HDMI

- 2× Type-A (1 USB 3.2) - 2× Type-C (1 PD + DP Alt Mode) - 1× HDMI / DP

/ - 1× Type-A (USB 3.2) - 3× Type-C ( 2 Thunderbolt 4) - 4K - 100W PD

<b>1</b>	/ -	GaN	30-67W	-	PD + PPS	-	Anker	Baseus
<b>2</b>	-	GaN	100-150W	-	2C1A	3C	-	- Anker 747 (150W) Baseus 160W
<b>3</b>	+	-	100W+	-		65W	-	GaN

## 3.10

	Reversible Plug	Type-C		
<b>Alt Mode</b>	Alternate Mode	Type-C	USB	/
<b>OTG</b>	On-The-Go		U	
<b>CC</b>	Configuration Channel	Type-C		PD
<b>SBU</b>	Sideband Use	Type-C	Alt Mode	
<b>DRP</b>	Dual-Role Power	Type-C		
<b>E-Marker</b>	Electronically Marked Cable			
<b>GaN</b>	Gallium Nitride			
<b>eGPU</b>	External Graphics Processing Unit		Thunderbolt	
<b>Daisy Chain</b>		Thunderbolt	6	
<b>PHY</b>	Physical Layer Chip			
<b>DP Mux</b>	DisplayPort Multiplexer		Alt Mode	

## 3.11

### 3.11.1

- [USB-IF](#)
- [USB Type-C](#)
- [Thunderbolt](#)

### 3.11.2

- [USB-IF](#)
- 

### 3.11.3

- **POWER-Z** USB
- **ChargerLAB KT002**
- **USB Device Tree Viewer** USB Windows

• **System Information** Mac      USB/Thunderbolt

---

[!NOTE] USB

USB4 Version 2.0 (80Gbps)

PD

USB-IF

## 4. 3 USB (USB Transfer Protocols)

---

USB                    USB-IF (USB )

### 4.1

- **USB 1.0 / 1.1:**
- **Low Speed:** 1.5 Mbps ( )
- **Full Speed:** 12 Mbps
- **USB 2.0:**
- **High Speed:** 480 Mbps         " "

### 4.2 USB 3.x

---

	(2013)	(2019)			
<b>USB 3.0</b>	USB 3.1 Gen 1	<b>USB 3.2 Gen 1</b>	USB 3.0 / 5Gbps	5 Gbps	8b/10b
N/A	<b>USB 3.1 Gen 2</b>	<b>USB 3.2 Gen 2</b>	USB 3.1 / 10Gbps	10 Gbps	128b/132b
N/A	N/A	<b>USB 3.2 Gen 2x2</b>	USB 3.2 / 20Gbps	20 Gbps	128b/132b

USB 3.2 Gen 2x2      Type-C      Type-C

### 4.3 USB4

---

USB4    Intel    Thunderbolt 3

- **USB4 Gen 2x2:** 20 Gbps
- **USB4 Gen 3x2:** 40 Gbps ( )
- 
- **(Tunneling)**      (USB 3.2)    (DisplayPort)    PCIe
- USB 3.2    USB 2.0    Thunderbolt 3

## 5. 4 Thunderbolt ( ) (Thunderbolt Technology)

---

Thunderbolt Intel Apple " " " "

### 5.1 Thunderbolt 3 ( 3)

- USB Type-C
- 40 Gbps
- PCIe x4 ( ) DisplayPort ( 5K/8K ) USB
- 3 USB 3.x USB

### 5.2 Thunderbolt 4 ( 4)

4 40 Gbps

#### 5.2.1 4 vs 3

<b>1. PCIe</b>	4 PCIe	<b>32 Gbps</b> ( 3 16 Gbps)	(eGPU)	SSD
2.	4 <b>4K</b>	<b>8K</b> ( 3 4K)		
3.	Intel VT-d DMA	DMA		
4.	4 <b>(Hub)</b>	1 3 3	(Daisy Chain)	

### 5.3 Thunderbolt vs USB4

- USB4 3
- 
- **USB4** " " 20Gbps 40Gbps PCIe
- **Thunderbolt 4** " " 40Gbps PCIe Intel
- **Thunderbolt 4 USB4** " "

## 6. 5 (Charging & Power Delivery)

---

USB                  2.5W (5V 0.5A)                  240W

### 6.1

#### 6.1.1 USB BC 1.2 (Battery Charging)

USB BC 1.2    USB-IF    2010

- 7.5W (5V 1.5A)
- D+/D-
- 
- **SDP (Standard Downstream Port)**    USB    500mA
- **CDP (Charging Downstream Port)**    +    1.5A
- **DCP (Dedicated Charging Port)**    1.5A
- 

### 6.2

#### 6.2.1

2010

- **USB 2.0**                  USB    **2.5W** (5V 0.5A)                  4-6
- **USB BC 1.2**                  7.5W (5V 1.5A)
- USB PD 1.0    2012                  2016    PD 3.0
- 
- "    5        2        "
- 
- 2013-2016    USB PD

OPPO                  "                  "

[!IMPORTANT]

#### 6.2.2

```
timeline
  title
  2010 : USB BC 1.2 (7.5W) :
  2012 : USB PD 1.0 :    PD    <br>
  2013 :    QC 1.0 (10W) :
  2014 :    QC 2.0 (18W) :
  : OPPO VOOC (20W) :
  2015 :    FCP (18W) :
  :        PE+ : MTK
  2016 :    QC 3.0 : 200mV
  :        SCP (22.5W) :    <br>
  : USB PD 3.0 :
  : vivo      (22.5W)
  2017 :    PE 3.0 (30W)
  :        QC 4 :    USB PD
  2018 : OPPO SuperVOOC (50W) :
  :        (27W)
  :        QC 4+
```

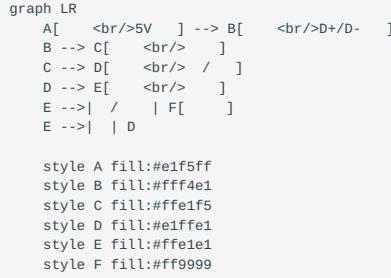
```

2019 : OPPO SuperVOOC 2.0 (65W)
    :     SCP 2.0 (40W)
2020 :     QC 5 (100W+) :     PD
    :     (120W)
2021 : OPPO 125W/240W :
    :     (210W)
    : vivo (200W)
2023 :     Type-C :

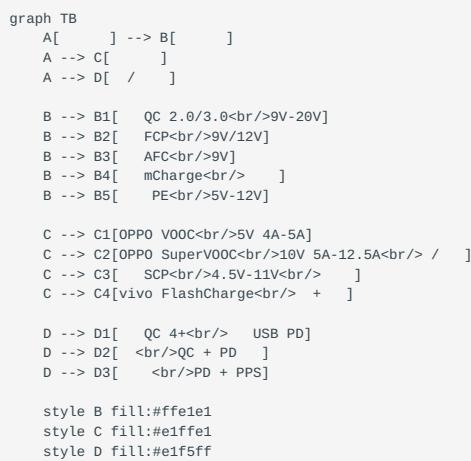
```

### 6.2.3

#### Handshake Protocol



1. 5V
  2. D+/D-
  - 3.
  4. /
  - 5.
- [!NOTE] D+/D-      USB      " " "



### 6.2.4 Quick Charge (QC)

Quick Charge

Android

#### QC 1.0 (2013)

- 10W (5V 2A)

- 
- 

**QC 2.0 (2014)**

QC 2.0

- 18W
- 
- Class A: 5V 9V 12V
- Class B: 5V 9V 12V 20V
- 3A
- D+/D-
- 5V D+ = D- = 0.6V
- 9V D+ = 3.3V, D- = 0.6V
- 12V D+ = 0.6V, D- = 0.6V
- 20V D+ = 3.3V, D- = 3.3V Class B

**QC 3.0 (2016)**

QC 3.0

- 18W 22W
- 3.6V - 20V
- **200mV** QC 2.0
- 
- 
- **38%** QC 2.0
- 
- QC 2.0

**QC 4 / QC 4+ (2017-2018)**

QC 4/4+ USB PD

- 28W (QC 4) 100W (QC 4+)
- 
- **USB PD 3.0** PD
- **PPS (Programmable Power Supply)**
- **INOV (Intelligent Negotiation for Optimum Voltage)**
- QC USB PD
- 

**QC 5 (2020)**

- **100W+**
- 98%

• USB PD QC	[!IMPORTANT] QC 4	USB PD	QC 4+	PD	iPhone MacBook
-------------	-------------------	--------	-------	----	----------------

---

## 6.2.5 OPPO VOOC

OPPO VOOC

### VOOC (2014)

- 20W
- / **5V 4A**
- 
- QC 5V 4A-5A
- 7 Micro-USB 5 2
- 
- **MCU ( )**
- 
- 
- 
- 

### SuperVOOC (2018)

SuperVOOC

- 50W
- / **10V 5A**
- 
- 2000mAh
- 10V 5V
- 5V 10V 5A
- 

### SuperVOOC 2.0 (2019-2020)

- 65W
- / **10V 6.5A**
- OPPO Find X Reno

### 125W / 240W (2021-)

OPPO - <b>125W</b> 10V 12.5A	- <b>240W</b> 24V 10A	OPPO	Type-C	VOOC
------------------------------	-----------------------	------	--------	------

---

## 6.2.6 FCP / SCP

**FCP (Fast Charge Protocol, 2015)**

- 18W
- 9V / 12V
- 2A
- D+/D-
- 

**SCP (SuperCharge Protocol, 2016)**

SCP	VOOC	SCP	FCP	FCP	FCP	SCP
•						
• SCP 1.0 22.5W (5V 4.5A 4.5V 5A)						
• SCP 2.0 40W (10V 4A )						
• SCP 3.0 66W (11V 6A)						
•						
•						
•						
•						
• FCP						
[!NOTE] FCP SCP		SCP	FCP	FCP	FCP	SCP

**6.2.7 Pump Express (PE / PE+)****Pump Express Plus (PE+, 2015)**

- 18-24W
- 5V - 12V
- 
- D+/D-
- 
- 
- QC

**Pump Express 3.0 (PE 3.0, 2017)**

- 30W
- 3V - 6V
- **USB Type-C** Type-C
- 20 70%

USB PD PE

## 6.2.8 vivo FlashCharge

vivo " "

### (2016)

- 22.5W
- / 9V 2.5A 5V 4.5A
- 

### FlashCharge 2.0

- 44W 55W 66W 120W 200W
- 
- vivo

## 6.2.9

USB PD

### (Mi Turbo Charge)

<b>QC 3.0 (2016-2017)</b>	-	18W (9V 2A / 12V 1.5A)	-	QC 3.0	-	5	Note 2	-		
<b>27W (2018)</b>	-	27W (9V 3A)	-	QC 4/QC 4+	USB PD	-	MIX 2S	8	-	QC PD

### (2019-2020)

<b>33W</b>	-	33W (11V 3A)	-	-	-	-	-	-	9 Pro Redmi K20 Pro
<b>50W</b>	-	50W (10V 5A)	-	+ USB PD	-	25W	-	10 Ultra	
<b>67W</b>	-	67W (11V 6.1A)	20V 3.35A	-	11V 6.1A	-	<b>USB PD</b>	20V 3.35A	-
		2250mAh	-	33.5W	-	11	Redmi K40 Pro		

### (2021-)

<b>120W</b>	-	120W (20V 6A)	12V 10A	-	<b>PD</b>	20V 6A	-	-	+ -			
2500mAh	-	MTW	-	15	4500mAh	-	11 Pro/Ultra	12 Pro				
<b>210W</b>	(2023)	-	<b>210W (20V 10.5A)</b>	-	<b>100W</b>	+	<b>15C</b>	2-3C	-	<b>MTW</b>	-	4
50% <b>9</b>			4900mAh	-	Redmi Note 12							

- **USB PD** iPhone MacBook - **QC** QC 3.0/4+

/

```
graph LR
    A["<br/>120W"] --> B[USB-C]
    B --> C["1<br/>60W"]
    B --> D["2<br/>60W"]
    C --> E["1<br/>2500mAh"]
    D --> F["2<br/>2500mAh"]

    style A fill:#fffe1e1
    style C fill:#e1f5ff
    style D fill:#e1f5ff
    style E fill:#e1ffe1
    style F fill:#e1ffe1
```

- 34 -

80%

		<b>PD</b>	<b>QC</b>
120W	120W	65W PD	18W QC 3.0
67W	67W	45W PD	18W QC 3.0
PD	27W-45W PD	PD	QC

[!TIP]

[!NOTE] 67W

USB PD

### 6.2.10 (mCharge)

- 18W 24W 36W
- QC
- 

### 6.2.11 AFC (Adaptive Fast Charging)

- 15W 18W
- 9V
- 1.67A (15W) 2A (18W)
- D+/D-
- QC 2.0 9V

[!TIP]

**USB PD + PPS AFC**

## 6.3

QC 2.0/3.0	18W	
QC 4+	100W	USB PD
VOOC/SuperVOOC	20-240W	OPPO/OnePlus/realme
FCP	18W	/
SCP	22.5-66W	/
PE/PE+	18-24W	MTK
AFC	15-18W	QC

## 6.4

---

### 6.4.1

- 
- 5V 1A/2A
- 
- QC 2.0/3.0 9V
- QC + FCP

### 6.4.2

- **VOOC**

- 
- 

### 6.4.3 USB PD

[!IMPORTANT] USB PD 3.0 **PPS** Type-C  
- QC 4+ USB PD - PD - PD + PPS - **OPPO/** PD

### 6.4.4

- 1.
- 2.
3. **USB PD** USB PD
- 4.

## 6.5 USB PD (Power Delivery)

---

USB PD **USB-IF** Type-C

### 6.5.1 USB PD

- ✗
- ✗
- ✗
- ✗

USB PD

### 6.5.2 USB PD

D+/D- USB PD **CC** Configuration Channel

**CC**

Type-C      CC      CC1    CC2

1.         Type-C
2.                 Source          Sink
3.         CC

**4. PD****PD**

```
sequenceDiagram
    participant C as <br/>(Source)
    participant D as <br/>(Sink)

    Note over C,D:
    C->>D: 1. (CC )
    C->>D: 2. 5V

    Note over C,D:
    C->>D: 3. Source_Capabilities<br/>()
    Note right of D: : 5V/3A, 9V/3A,<br/>15V/3A, 20V/5A

    D->>C: 4. Request<br/>( 20V 3A)

    C->>D: 5. Accept<br/>()

    Note over C,D:
    C->>D: 6. PS_RDY<br/>()
    C->>D: 7. 20V 3A

    Note over C,D:
    D->>C: Request<br/>
```

1.         Type-C    CC
2.                 5V
3.         Source\_Capabilities          /
4.         Request
5.         Accept      Reject
6.         PS\_RDY Power Supply Ready
- 7.

[!IMPORTANT] USB PD                 "          "          D+/D-    "    "          PD

---

### 6.5.3 PD

USB PD      CC

<b>Source_Capabilities</b>	Source → Sink	
<b>Request</b>	Sink → Source	
<b>Accept</b>	Source → Sink	
<b>Reject</b>	Source → Sink	
<b>PS_RDY</b>	Source → Sink	
<b>Get_Sink_Cap</b>	Source → Sink	
<b>Soft_Reset</b>	Both	PD
<b>Hard_Reset</b>	Both	5V

### 6.5.4

#### PD 2.0 / 3.0 (2016-2018)

- **100W** (20V 5A)
- 
- 5V
- 9V 12V 15V 20V
- 5A E-Marker
- 
- **45W** 5V/3A, 9V/3A, 15V/3A, 20V/2.25A - **65W** 5V/3A, 9V/3A, 15V/3A, 20V/3.25A - **100W** 5V/3A, 9V/3A, 15V/3A, 20V/5A

#### PD 3.1 (2021)

- **240W** (48V 5A)
- **EPR (Extended Power Range)**
- 28V 36V **48V**
- 
- **EPR**

### 6.5.5 PPS (Programmable Power Supply)

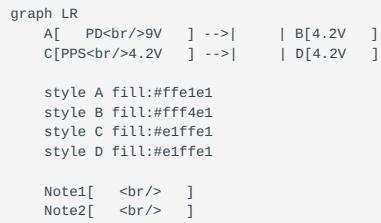
PPS    **USB PD 3.0**

#### PPS

PD      5V 9V 15V 20V      -      9V      4.2V -      9V → 4.2V -

**PPS**

- 3.3V - 21V PD 3.0 PPS
- **20mV** 0.02V
- 

**PPS**

- ⚡
- 🌡️
- 💡 5-10%
- 📱

**PPS**

PPS

PPS		
0-30%	3.6V	3.8V
30-70%	3.9V	4.1V
70-90%	4.1V	4.3V
90-100%	4.3V	4.4V

[!NOTE] " 2.0" "PD" PPS iPhone 15 Pro PPS

**6.5.6 USB PD vs**

USB PD		
✓	USB-IF	✗
✓		✗
CC	D+/D-	/
" "		
240W (PD 3.1)	240W (OPPO)	
✓ PPS 20mV		QC 3.0 200mV
✓		
✓	✗	
✓		⚠

**PD**

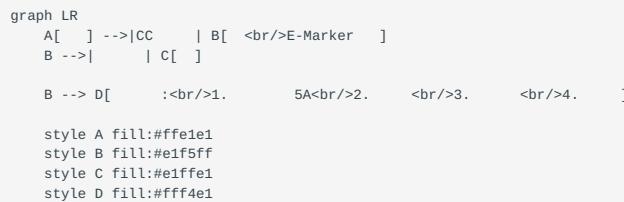
1. 2024 USB-C
  2. PPS PD
  3. PD
  - 4.
- [!IMPORTANT] OPPO **USB PD** " "

## 6.6 (E-Marker )

Type-C

- **3A** C-to-C 60W (20V 3A)
- **5A** **E-Marker** " 5A " 100W (20V 5A)
- **EPR** PD 3.1 240W

### 6.6.1 E-Marker



[!WARNING] 3A 100W 60W

## 6.7

### 6.7.1 1

66W (SCP)	Mate 40 Pro	66W	65W	SCP	
66W (SCP)	11	66W	27W	USB PD	PD
66W (SCP)	iPhone 14 Pro	66W	27W	USB PD	PD iPhone
OPPO 65W (VOOC)	OPPO Find X5 Pro	65W	65W	SuperVOOC	
OPPO 65W (VOOC)	11	65W	10W		
OPPO 65W (VOOC)	iPhone 14 Pro	65W	0W		VOOC PD
120W	12 Pro	120W	120W		
120W	iPhone 14 Pro	120W	27W	USB PD	PD iPhone
120W	MacBook Pro 14	120W	96W	USB PD	PD
140W (PD)	MacBook Pro 16	140W	140W	USB PD 3.1	
140W (PD)	12 Pro	140W	67W	USB PD	PD
140W (PD)	Mate 40 Pro	140W	27W	USB PD	PD SCP

USB PD    -    + PD    -    SCP    PD    -    **OPPO VOOC**

### 6.7.2 2

11 Pro (67W) + 67W

0-50%				
6A	67W	15		
5A E-Marker	60W	17		
3A	18W	45		
	10W	70		
1	67W	15		
3	25W	35		

- - - - >60W 5A/6A

## 6.7.3 3

<b>1</b>	<b>PD</b>	-	Anker	-	100W / 140W USB-C PD	-	USB PD 3.0/3.1 + PPS + QC 4+ - Switch -
<b>2</b>	<b>GaN</b>	-	Anker	-	100W / 120W - Anker 747 (150W) -	2C1A / 3C1A 100W (C1) / 100W (C2) -	USB PD 3.0 + PPS + QC 3.0/4+ - 100W + 50W - 65W + 45W + 40W
<b>3</b>		-	Baseus Ugreen	-	200W+	4-6	-
[!TIP]	<b>GaN</b>				100W GaN		1/3

## 6.8

## 6.8.1

<b>USB BC 1.2</b>		<b>USB PD</b>
<b>(OVP)</b>	5-10V	+
<b>(OCP)</b>	MCU	CC
<b>(OTP)</b>	/	
<b>(SCP)</b>	BMS +	BMS + PD
		E-Marker
		PS_RDY
		Role Swap

## 6.8.2

- 1.
2. USB-IF
3. USB-IF
4. " "
- 5.
6. /
7. >50°C
8. VOOC/SuperVOOC
- 9.
10. 100%
11. 80-90% " "
- 12.
13. <0°C >40°C
- 14.
- 15.

16.  
17.

---

## 6.9

<b>USB-IF</b>	USB Implementers Forum	USB	USB
<b>D+/D-</b>	Data Plus / Data Minus	USB	
<b>CC</b>	Configuration Channel	Type-C	PD
<b>E-Marker</b>	Electronically Marked Cable		
<b>MCU</b>	Microcontroller Unit		
<b>BMS</b>	Battery Management System		
	Direct Charging		
	Dual-Cell Battery		
	Multi-Tab		
	Handshake Protocol		
<b>GaN</b>	Gallium Nitride		
<b>PPS</b>	Programmable Power Supply	PD 3.0	20mV
<b>EPR</b>	Extended Power Range	PD 3.1	28V-48V 240W
<b>OVP</b>	Over Voltage Protection		
<b>OCP</b>	Over Current Protection		
<b>OTP</b>	Over Temperature Protection		
<b>SCP</b>	Short Circuit Protection		SuperCharge Protocol
<b>C-to-C</b>	USB-C to USB-C	Type-C	Type-C
<b>A-to-C</b>	USB-A to USB-C	USB-A	Type-C

---

## 6.10

### 6.10.1

- USB Power Delivery Specification (USB-IF )
- USB Type-C® Cable and Connector Specification
- Qualcomm Quick Charge

### 6.10.2

- **POWER-Z** USB
- **ChargerLAB KT002** PD
-

### 6.10.3

- USB-IF
- 

[!NOTE]

2023

USB-IF

7. 6

## (FAQ & Common Misconceptions)

---

### 7.1 Q: Type-C

---

A: 1. USB 2.0 E-Marker 3A 65W/100W 2. PD  
VOOC 10W 3.

### 7.2 Q: Type-C

---

A: Type-C C - **9.9** + USB 2.0 - USB 3.2 (10Gbps) + 4K + 100W - **4** 40Gbps  
+ 8K + 240W Logo

### 7.3 Q: 65W

---

A: USB PD " " " 9V 2A " 18W PD 5V 1A 5V 2A

### 7.4 Q:

---

A: - 5A 4 - USB 3.2